

The twinning rate of sika deer, *Cervus nippon*, on Mt. Goyo, northern Japan

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Abstract. Knowing demographic parameters is important in order to understand the life history of mammals. As an example, the twinning rate of sika deer, *Cervus nippon*, on Mt. Goyo was determined based on 2,064 samples collected from 1981 to 1997. The sex ratio of single fetuses ($n=1,946$) was even (49.8% males and 50.2% females). Six pairs (0.29%) of twins were found. One pair was composed of male and female embryos, suggesting that at least some conceptions are dizygotic. It was concluded that twinning is rare in sika deer. This rate was similar to, or lower than, that found in red deer, *C. elaphus*.

Key words : *Cervus nippon*, Japan, reproduction, sika deer, twinning.

Many of the life history variables among mammals may be best explained on the basis of body size. The "Fast-slow continuum" theory (Eisenberg 1981, Stearns 1983, Martin and MacLarnon 1985), for example, has shown that smaller-bodied mammal species are not merely short-lived, but that they typically produce large litters of rapidly developing young, whereas larger mammals produce fewer young which develop slowly and live longer. There are, however, exceptions. Sika deer, *Cervus nippon*, for example, the males of which weigh 80 kg and the females of which weigh 50 kg, usually produce single offspring, while similarly sized *Odocoileus* species (Wallmo 1978) and the very much larger moose, *Alces alces*, the largest extant species of deer, regularly carry twins (Franzmann 1978). These differences may be better explained in terms of variation in species-specific habitat quality than in terms of mere body size. The habitats of *Odocoileus* species and moose are dominated by browse, which prevents detection by predators (Geist 1981).

In order to fully understand the life histories of mammals, a comprehensive range of parameters including body size, phylogenetic relations and habitat quality must be investigated (Wootton 1987, Harvey *et al.* 1989), and precise quantitative data is essential. Among the various life history variables, demographic information is one of the most important (Millar and Zammuto 1983, Fowler 1987).

Although the pregnancy rates and the age of weaning are fairly well known for sika deer (Koizumi 1992, Takatsuki 1992, Kaji 1995, Asada and Ochiai 1997), it was believed until recently that twinning did not occur in wild populations

(Feldhamer and Marcus 1994). There have been, however, several reports of twinning both in captivity and in the wild.

I have collected information on sika deer pregnancies since 1981 on Mt. Goyo, northern Japan, and have found several cases of twinning among more than 2,000 females. The objectives of this paper, therefore, are to report on twinning in this population and to review previous reports on twinning in sika deer and in the closely related red deer, *C. elaphus*.

MATERIALS AND METHODS

Sika deer were shot for pest control on Mt. Goyo in northern Honshu, Japan, between January and March each year from 1981 to 1997. The deer carcasses were brought to checking stations where whole body weights were determined to the nearest 0.5 kg using spring scales prior to dissection. As conception takes place during the autumn rut, fetuses were already well developed and generally weighed 100-900 g during the sampling period, thus it is believed that none were overlooked. The rate of twinning was examined among 2,064 culled females. The sex of the fetuses was determined by genital examination, though some fetuses ($n=124$) were too badly injured as a result of the shooting of their mothers for their sexes to be determined (Table 1). The ages of the adults were determined by examination of the cementum annuli of the first incisors, or were estimated from the wear of the incisors (Ohtaishi 1976) according to known age-wear relationships (Takatsuki, unpublished).

RESULTS AND DISCUSSION

Since sample sizes were small during the 1980s, they were rounded (Table 1). Of the total of 2,058 single fetuses examined, 1,934 were sexed and among these the sex ratio was even (females 50.2%, males 49.8%, χ^2 -test, $p > 0.05$). If twins were added ($n=1,946$), the sex ratio was completely even (males and females=50.0%).

Table 1. Number of pregnant females and sex of fetuses of sika deer on Mt. Goyo through 1981-1997. f: female, m: male.

Year	Sex unknown	Single		Twin			Total
		female	male	f-f	f-m	m-m	
1981-89	5	93	107	0	1	1	207
1990	0	38	52	0	0	0	90
1991	1	89	70	0	0	0	160
1992	0	87	96	0	0	1	184
1993	7	197	123	0	0	0	327
1994	3	176	191	0	0	1	371
1995	28	102	102	0	0	1	233
1996	7	90	116	1	0	0	214
1997	73	98	107	0	0	0	278
total	124	970	964	1	1	4	2,064

Table 2. Information of females carrying twins.
*Figures in parentheses are estimated age from wear.

No.	Locality	Date of sampling	Body weight kg	Age year	Wear class
83068	Ofunato	Mar. 21, 1983	—	1.5	II
87012	Ofunato	Feb. 21, 1987	49.5	9.5	III ₃
92229	Kamaishi	Feb. 29, 1992	52	(3.5*)	III ₁
94553	Sanriku	Jan. 8, 1994	45	(10.5)	V
95186	Kamaishi	Feb. 26, 1995	50	(?)	?
96220	Takada	Feb. 1, 1996	45	(1.5)	I

Among the 2,064 pregnant females examined, six (0.29%) were carrying twins (Table 1), indicating that while twinning does occur, it is exceptional in this population.

Records of twinning are very rare among wild sika deer. Suzuki (1995) reported one example (1.1%) among 89 pregnant females in one Hokkaido population, and Uno (personal communication) found two sets of twins (3.4%) among 58 pregnant females in another, though he considered that this rate might be high because of his small sample size. Feldhamer and Marcus (1994) reported that a set of healthy sika deer twins was carried by one female among 54 females introduced to Maryland, USA. Five sets of twins (4.6%) among 108 births (Zuckerman 1953) and one set (1.20%) among 83 births (Haensel 1980) have been reported from German zoos. The sample size of the present study (2,064 females) was very much greater than in any of these cases thus the results from this study may be more reliable.

Among both Eurasian red deer and North American wapiti (elk) populations, both close relatives (both *Cervus elaphus*) of sika deer, twinning is also very rare (see review in Mitchell *et al.* 1977 and Sadleir 1987). Guinness and Fletcher (1971) recorded only one example among Scottish red deer, while other studies have indicated that twin embryos among red deer occur at rates ranging from less than 0.2% to 2.0% (less than 0.2%, Mitchell 1973; 0.2%, $n=1,690$, Kittams 1953; 0.2%, $n=1,186$, Flook 1970; 0.6%, $n=1,106$, Greer 1968; 1.2%, $n=875$, Korning and Vorreyer 1957), and 2.0% ($n=97$, Brna 1969).

During the present study, the combinations of twins were: one female-female set, one female-male set, and four male-male sets (see Table 1). Male and female twins were also reported among Hokkaido sika deer by Suzuki (1993), further indicating that at least some conceptions are dizygotic.

The data collected during the present study of the Mt. Goyo population provides no evidence for any particular tendency towards twinning in any particular locality, period, body weight, or age (Table 2). Since pregnancy among red deer is known to be affected by nutritional conditions (Mitchell *et al.* 1977), further studies of other populations are required to clarify what factors affect twinning in sika deer.

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